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It is hereby certified that annexed here to is a true copy of **Application, Provisional Specification & Abstract** of the patent application as filed and detailed below:-

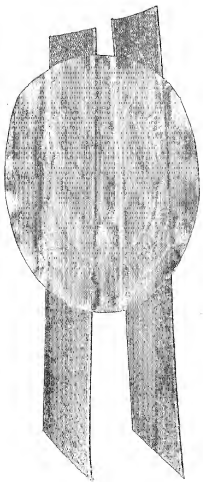
Date of application : **15-12-2003**

Application No : **1013/CHE/2003**

Applicants : **M/s. Matrixview Pte Ltd, 9, Shenton Way #05-02, Singapore 068813.**

In witness there of
I have here unto set my hand

Dated this the 18th day of March 2005
27th day of Phalguna, 1926(Saka)



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ORIGINAL 1013/CHE/2003

FORM 1

The Patents Act 1970
(39 of 1970)

APPLICATION FOR GRANT OF A PATENT
(See sec.5 (2), 7, 54 and 135 and Rule 33A)

Matrixview Pte Ltd
9 Shenton Way #05-02
Singapore 068813
Tel: (65) 6336 2777

1013/CHE/2003
15.12.2003

1. Hereby declare –
   (a) That we are in possession of an invention titled **"NOVEL ALGORITHM FOR ADAPTIVE AND SCALABLE DATA COMPRESSION"**
   (b) That the Provisional Specification relating to this invention is filed with this application.
   (c) That there is no lawful ground of objection to the grant of a patent to us.

2. Further declare that the inventor for the said invention is,

   Arvind Thiagarajan
   H 24/6, Vaigai Street, Besant Nagar
   Chennai 600090. Nationality - Indian

3. We, claim the priority from the application(s) field in convention countries, particulars of which are as follows:-

   Not applicable

4. We state that the said invention is an improvement in or modification of the invention, the particulars of which are as follows and of which we are the applicant/patentee:

   Not applicable

5. We state that the application is divided out of our application, the particulars of which are given below and pray that is application deemed to have been filed on _____ under section 16 of the act.

   Not applicable

6. That we are the assignee of the true and first inventor.

Not applicable

7. That our address for service in India is as follows:

Matrix View Technologies (India) Private Limited
No.69, Mahalakshmi Koil Sreet
Kalakshetra Colony, Besant Nagar
Chennai 600090. TAMILNADU. INDIA.

8. Following declaration was given by the inventor or applicant in the convention country declare that the applicant herein is our assignee or legal representative

Not applicable

9. That to the best of my knowledge, information and belief the facts and matters stated herein the correct and that there is no lawful ground of objection to the grant of patent to us on this application.

T. Arvind

Mr. Arvind Thiagarajan
(Inventor)

10. Following are the attachment with the application:

a) Provisional specification (3 copies)
b) Fee of Rs.

I request that a patent may be granted to us for the said invention

Dated at Chennai on this 11th day of December, 2003

Anand -T

Mr. Anand Thyagarajan
(Authorized Signatory)

To

The Controller of Patents
The Patent Office
At Chennai

FORM 2

The Patents Act, 1970

Provisional Specification

Section 10

"NOVEL ALGORITHM FOR ADAPTIVE AND SCALABLE DATA COMPRESSION"

Applicant:

ARVIND THIAGARAJAN
H 24/6, Vaigai Street
Besant Nagar, Chennai 600090
TAMILNADU. INDIA.

The following Provisional Specification describes the nature of the invention and the manner in which it is to be performed.

Field of Invention

The present invention relates to the Adaptability and Scalability optimization of image or other highly correlated data compression

Background of Invention

The role of data and image compression assumes significant importance as the world makes a paradigm shift from analog to digital systems. Data compression, which was impossible due to the inherent disadvantages of the analog systems, has become a feasible reality with digital systems. The computational overheads and the complexity posed the most serious threat to the development data compression. With the advent of high-speed digital processors with MIPS capability most of these problems have been overcome.

Image compression has many practical applications, which are driven by the fact that image data is a highly correlated data stream. Image compression can be either lossy or lossless depending on the criticality and nature of the application.

Lossy compression is used in data such as sounds and pictures, applicable on the Internet , streaming media and telephony applications. Where in a small loss of quality can be tolerated without losing the essential nature of the data . In these cases, the retrieved file can be quite different to the original at the bit level while being indistinguishable to the human ear or eye for most practical purposes. Sound and image data can be highly compressed without degrading the quality of the sound and the human eye can see only certain frequencies of light ,makes lossy compression appropriate in certain

applications. This novel invention offers a flexible lossy option in addition to lossless compression, which in certain applications is the ideal solution that produces significantly high compression ratios, and rendering smaller compressed files, while still meeting the requirements of the application.

Current Image Compression Technologies

Image compression technologies can be broadly classified as either Lossy or lossless. An image compression technology can be classified as Lossy or Lossless depending on whether the subsequent decompression of the compressed data produces an exact pixel-to-pixel replica of the original data or not.

We can logically infer from the that any efficient compression technique requires a transformation also known as pre – coding, which in turn aids in increasing the efficiency of the second step, the entropy coder. At this stage it must be emphasized that if the entropy coder has to produce good compression ratios then the pre – coding should transform the data into a form suitable for the entropy code. If the transformation is not efficient enough then the entropy coder is rendered redundant. Hence it can be logically concluded that the pre-coding or the transformation is the most important stage of any image compression algorithm

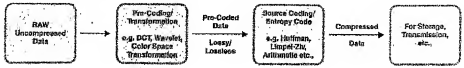

Fig 1. Block Diagram of a general Image Compression Algorithm

The most popular pre – coding transformation used in image compression is the Discrete Cosine Transform (DCT). This transformation gives the frequency and extent of data change inside and image. Another important property of any transformation is that it should be reversible too, so that the reverse process can be applied at the decompression stage to obtain the original image. This transformation is extensively used in the JPEG algorithms and its variants

As indicated above DCT is a reversible transform whose forward transform is given as

$$DCT(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cdot \cos\left[\frac{(2y+1)j\pi}{2N}\right]$$

where $C(x) = \frac{1}{\sqrt{2}}$ if $x = 0$, else 1 if $x > 0$.

The above-mentioned technique poses the following problems

The complexity of the equation in terms of the number of multiplications and additions, The most straightforward way to implement the DCT is to use the defining Equation In the 2D case, with arrays of dimensions $N \times N$, the number of multiplications is on the order of $2N^3$ using a separable approach of computing 1D row and column DCT's. Specifically, for an 8 × 8 pixel array, which is used in the JPEG family we have 1024 multiplications and 896 additions. In spite of the tremendous improvement made in terms of reducing the number of computations, the reduction has not been significant enough to reduce the tremendous overhead it places on the hardware that implements the algorithm.

Even though the image data is an integer, their multiplication to cosine terms in the formula produces fractional numbers or real numbers because cosine values are fractional in nature until and unless they are integer multiples of Pi, which might not be the case. Since fractional numbers need infinite precision to store them exactly they might produce errors in the reverse process resulting in losses.

Another popular transformation used is called the wavelet transform, which is used in the latest image compression techniques like JPEG2000. This uses a mother wavelet to decompose the image data into frequency sub - bands, which in turn increases the redundancy in most of the sub – bands hence improving compression ratios. Used in their original form the mother wavelets do not give integer-to-integer transformation but when used after a process called lifting they become integer-to-integer transforms thereby making the entire process lossless but does not give a high compression ratio.

Color Transformations also offer an interesting prospect to compression. Commonly used color space is RGB where every pixel is quantized by using a combination of Red Green and Blue (Primary Colors) values. This format is ideally suited for designers but no so ideal for a compression algorithm.

The human eye is more sensitive to luminance than color hence Chrominance Luminance and Value format offers an interesting perspective to compression. This prospect of using color transformations in image compression is instrumental in the visually lossless algorithms. Using lossy color transformation provides an effect equivalent to that of quantization in other processes, in the sense that it cannot resolve the difference between small values, hence using the same integer value for two different integer values with

a small difference. As a result of this a redundancy is affected with a 24-bit level. This increased redundancy in data in turns gives a high compression ratio.

This process is not a perfectly reversible process. In other words, the de-compressed image data is different from the original image data. The degree of difference depends on the quality of compression and also the compression ratio. The user-defined adjustment of the quality parameter of the algorithm can produce very highly compressed visually lossless images.

Description and principle

Image data is highly correlated that is adjacent pixels have are closely related. Hence it is possible to create a significant redundancy, which is then followed by a unique combination of existing data transforms and source encoders to achieve higher compression ratios.

This Unique Invention provides a unique solution where in we can achieve higher compression ratios without having to make a compromise in quality. This essentially means that a very high compression ratios can be achieved by maintaining the pixel-to-pixel integrity of the image data during the compression and decompression process. This Novel Invention is an algorithm that exploits the close correlation between adjacent pixels.

The Data Compression divides the Pre Coding block of the compression process into two logical stages, (a) the transformation and (b) the data – rearrangement stage. This transformed and re – arranged data is passed as an input to the source coder, which comprises of an arithmetic coder preceded by a Run length encoder.

The data re-arrangement stage of the algorithm brings about the optimization of compression. The optimization algorithm consists of end-to-end reversible sort along with a last to front transform. The rearranged data optimizes compression by creating a redundancy and increasing the compression ratio.

This unique algorithm is scalable by virtue of the fact that the quality of the compressed image can be user defined without any significant change in the structure of the algorithm. In such a case, when a large set of data is to be compressed into a limited amount of disk space, as applicable on the Internet, streaming media and telephony applications, it might be required to make a compression ratio - quality tradeoff for individual images or a group of images. This novel invention offers flexibility by providing a user-friendly image quality metric.

This unique algorithm supports compression of selective areas of the image. The selected region of the image can be compressed in a lossless manner, with the other areas being compressed in a lossy manner. The complexity overhead of optimizing across the images is minimal, while significant gains in compression/quality are obtained.

This unique invention provides a unique solution where in we can achieve higher compression ratios, without having to make a compromise in quality. This essentially means that this novel invention can be used to achieve very high compression ratios maintaining a lesser pixel-to-pixel error. The scalability of the present algorithm is maintained by exploiting the close correlation between adjacent pixels by artificially creating redundancy.

This invention gives a lower MEAN SQUARE ERROR (MSE) as compared to JPEG, JPEG 2000. In JPEG, the MSE is higher due to the quantization process. In this visually lossless algorithm, the pixel-to-pixel losses are smaller, delivering high compression ratios.

Scalability in Data Compression

- **Mean-Square Error**

$$MSE = \sqrt{\frac{1}{m \times n} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (t(i,j) - a(i,j))^2}$$

Applications of the Present Invention

Repetition Coded Compression can be used in a wide gamut of applications ranging from Medical Imaging to Digital Entertainment to Document management. Each of these verticals requires Repetition Coded Compression to be implemented in its own unique way to deliver a robust and powerful end product.

Repetition Coded Compression could be deployed in the following forms for commercialization.

1. Chip – (ASIC, FPGA etc.)
2. DSP, Embedded Systems
3. Standalone Hardware boxes

4. Licensable Software (as DLL's OCX etc.)

5. Software deliverables

Thus, the above mentioned account describes the invention in detail. It is intended that the foregoing description is only illustrative of the present invention and it is not intended that this unique invention be limited or restricted thereto.

Many specific embodiments of this novel invention will be apparent to one, skilled in the art from the foregoing disclosure. The scope of the invention should be determined not only with reference to the above description but to all other additions, substitutions & modification of the present invention without departing from the spirit of this invention.

Abstract

The present invention is a perfectly loss less compression algorithm, which, as an addition / option also offers customized compression by having a unique property of scalability and adaptive optimization.

Present Invention is scalable by virtue of the fact that the quality of the compressed image can be user defined without any significant change in the structure of the algorithm. In such a case, when a large set of data is to be compressed into a limited amount of disk space, it might be required to make a compression ratio - quality tradeoff for individual images or a group of images. The user-defined adjustment of the quality parameter of the algorithm can produce very highly compressed visually lossless images.

Present Invention offers - flexibility in choosing the image quality metric and allows various constraints to be placed on compression/quality for individual images needed to be compressed to fit in the available space.

Present Invention supports compression of selective areas of the image. The selected region of the image can be compressed in a lossless manner, with the other areas being compressed in a lossy manner. The complexity overhead of optimizing across the images is minimal, while significant gains in compression/quality are obtained.

The simple mathematical transformations in Present Invention make hardware implementations less complicated and also the fact that hardware systems work ideally on integer arithmetic, makes Present Invention best suited for the same.